SECRET

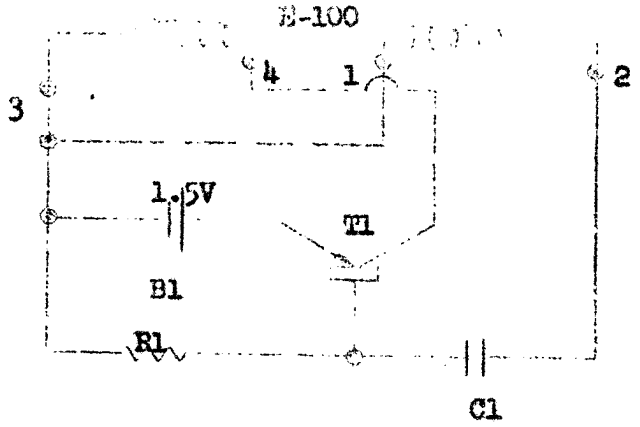
Chief, Supplemental Programs Division, OC 13 December 1957

Chief, Engineering Division, OC

Elgin Electro-Mechanical Oscillator - Type E-100; It's Use as a 1000 cps Reference Oscillator (Lab.Project 2517)

1. The R&D Laboratory recently completed the fabrication of ten reference oscillators based on the Philamon Model J 1000 cycle/second tuning fork. At the completion of this phase of the project it was suggested that a smaller unit might be obtained by using the Elgin Electro-Mechanical Oscillator type E-100 as the frequency determining element. A study of the Elgin unit has indicated that it will not provide an oscillator as precise as the Philamon fork and that it did not meet the published specifications. The following resume of Laboratory findings is forwarded in confirmation of a recent telecon between [redacted] of the Laboratory and [redacted] of your office. 25X1 25X1

2. The results presented in the following paragraphs are based on measurements made using the oscillator in the circuit shown below. This circuit was suggested by Elgin.



3. A CK721 transistor (T1) was used. The battery (B1) drain at 1.5 volts was approximately 1.5 ma. The minimum value of capacity (C1) was found to be 1 microfarad. Maximum output was obtained using a 100,000 ohm resistor (R1).

4. The frequency of the Elgin oscillator was found to be position sensitive. In a horizontal position, and also in a vertical position with the output terminals pointing downward, the frequency was 999.6 cps. If the oscillator is turned so the output terminals face upward,

CONFIDENTIAL

SECRET

DOC 8 REV DATE 4-12-80 OPI 008632
ORIG COMP ___ OPI ___
ORIG CLASS S PAGES 5
JUST 22 REV 2010

c

the frequency decreases to 999.0 per cps. Furthermore, a detectable variation in frequency occurs when the oscillator is rotated in the horizontal position.

5. The oscillator was checked over the temperature range from minus 40 to plus 40° C. For this check only the oscillator proper was placed in the temperature chamber. Frequency variations with change in temperature are as indicated below:

Temperature	Frequency
-40° C	1002.4
-20° C	999.0
0° C	998.3
20° C	998.2
40° C	997.6

6. A comparison of the Elgin and Philamon units on the basis of temperature stability over the minus 40 to plus 40° C range is shown below:

Elgin Oscillator: 4.3/1000 = 4.3 X 10-3 parts/cycle over the temperature range.

Philamon Fork: 1/10,000 = 1 X 10-4 parts/cycle over the temperature range.

The ratio 4.3 X 10-3/1 X 10-4 = 43, indicates a frequency change in the Elgin that is 43 times greater than given by the Philamon fork. Elgin specifies a temperature variation of 2 parts/100,000 per degree F over the range from 0 to 150° F. Laboratory measurements were made over the range from 0 to 104° F, and they indicate that the oscillator is within the specifications over this part of the range. However, in the restricted range from plus 40 to plus 100° F measurements indicate that the unit is not within specifications by a factor of 2.6. Elgin specifications for the restricted range permit a variation of 0.5 parts per 100,000 per degree F or 0.3 cps. The measured variation was 0.8 cps.

7. In conclusion, it is noted that even though the Elgin unit is within specifications in the temperature range from 0 - 104° F this specification allows 10 times the frequency variation permitted by the reference oscillator specification (0.1 cps). The excessive position error (50 times Elgin specifications) noted herein is an additional factor of importance when considering the unit as a precision reference.

R&D/Lab/AJS/rkb (23 December 1957)
Distribution:
Original and 1 - Addressee
1 - R&D Lab Subj.
1 - OC-E Reading
1 - OC-E Chrono
1 - R&D Chrono 1 - Dev/s

25X1

STANDARD FORM NO. 64

Office Memorandum • UNITED STATES GOVERNMENT

TO : File: 2517

DATE: 27/Mar/58

FROM : Fixed Freq. Osc. (1000 c/s) (Unijunction)

SUBJECT:

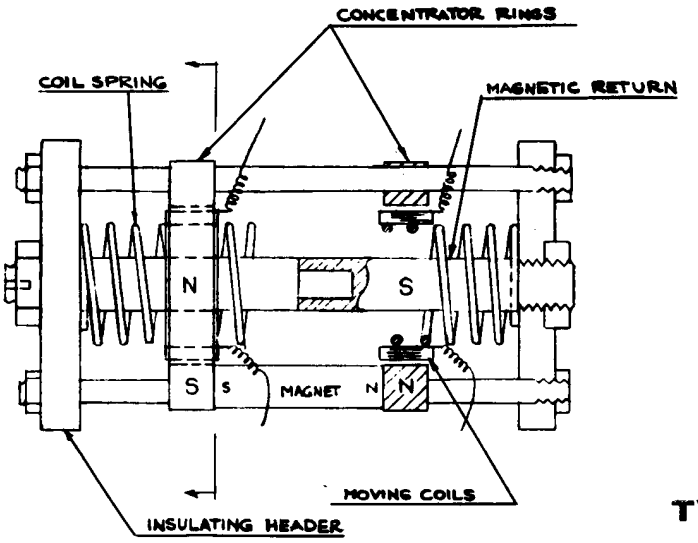
Serial No.
178

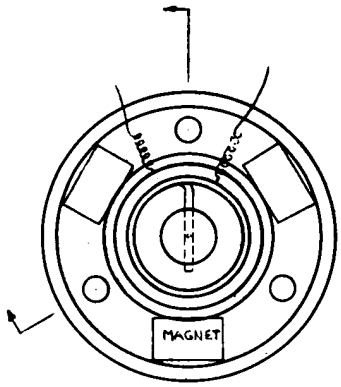
Date Completed
27/Mar/58

File on 2517

ELGIN

Electro-Mechanical Oscillator





TYPE E-100

Patents Pending

The Electro-Mechanical Oscillator as shown in the above figure is a device capable of being used as a frequency standard or frequency selecting device in frequency ranges heretofore unattainable with simplicity and accuracy.

Some of the more apparent advantages of this device are that it is **lightweight, compact, portable,** operates in the microwatt range of power, and combines rugged construction with performance characteristics comparable to high quality tuning forks.

Another equally valuable advantage is that it may be operated with a simple, single transistor circuit which provides undistorted sine wave output and self-starting operation.

Upon examining the sketch of the Electro-Mechanical Oscillator, it will be seen that the unit consists of a helically wound coil spring held at each end by a rigid structure. Mounted solidly on the spring at vibration antinodes are two coils of fine wire which move in a radial magnetic field generated by the surrounding magnetic structure.

One coil of wire serves as the drive coil and causes the spring to vibrate in its second mode as a signal of proper frequency is fed into the coil. The driving force is obtained through the interaction of the coil field and the fixed field. The resultant movement of the other coil or output section in the fixed magnetic field feeds a portion of the signal generated in it back to the drive coil through an amplifying circuit. At a certain magnitude the oscillations become self-sustaining at a frequency which corresponds to the second mode resonant frequency of the coil spring.

It is anticipated that the cost of this unit will be comparable to and probably lower than similar frequency sensitive devices.

See other side for specifications.

ELECTRONICS DIVISION

ELGIN NATIONAL WATCH COMPANY

107 National Street, Elgin, Ill.

Tentative Specifications—Type E-100

A. Oscillation in the 100 to 1500 cycles per second range.

At the present time oscillators are being built in 200-400 cycle range using only slight modifications from one basic design to achieve this range. Indications are that higher and lower frequencies can be easily obtained with some redesign.

B. Size, depending upon application, from 1/32 to 1 cubic inch.

The oscillator may be hermetically sealed and provided with standard tube bases for plug-in applications or simple brackets for printed circuit board mounting.

C. Weight range from 1/10 ounce to 1 ounce.

Original models have been sealed in metallic cans.-It will be possible to incorporate shock mountings in the assembly and vibration isolation mountings to protect the oscillator from external vibrations. Since the oscillator vibrates in the second mode, energy is not transferred to the mounting from the oscillator itself due to the cancellation of forces within the vibrating spring.

D. Position error, 1 part in 100,000 in any position.

1 part in 1660 .6/1000

E. Amplitude error.

Frequency change with change in amplitude of vibration can be expected to be less than 1 part per 100,000 when the device is used in circuitry such as customarily employed with tuning fork oscillators.

6.4

F. Temperature error .5 part in 100,000 per degree Fahrenheit over a range of 40°F to 100°F.

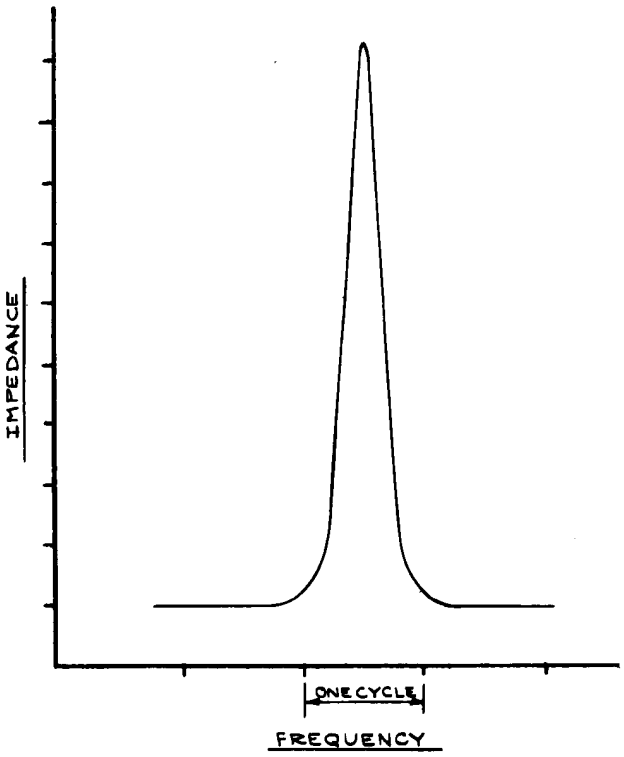
In the range of 0°F to 150°F, the temperature error is about 2 parts in 100,000 per degree Fahrenheit.

G. Selectivity—10 to 1

When the Electro-Mechanical Oscillator is operating as a frequency sensing device the impedance at the resonant frequency is 10 times that at non resonant frequencies. The Q of the device, as determined from the accompanying frequency response curve, is greater than 1500.

H. Power requirements—about 10 microwatts

At 10 microwatts, a median amplitude of vibration, suitable for most applications, can be obtained.



ELECTRONICS DIVISION
ELGIN NATIONAL WATCH COMPANY
107 National Street, Elgin, Ill.

.7 cps - 0-40
.2 cps — 0-40

.5 p/100000/°F
5×10^{-3} p/1000 °F
*60
.3 p/1000 — ±40 – +100F

.5 p/100,000/°C
5×10^{-3}/1000/°C
110

0-40
.2 cps

5×10^{-3} p/1000/°F
200×10^{-3}/p/1000°F

.2 cps

999.9
1000.1

ELGIN

PATENTS PENDI

Electro-Mechanical Oscillator

TYPE E-100

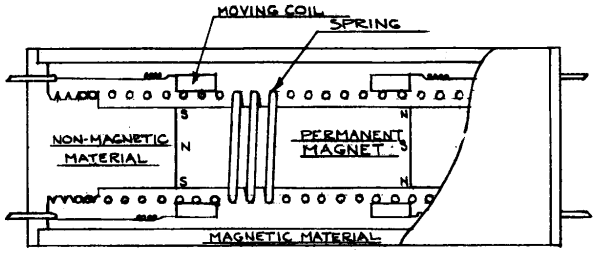
INSTRUCTION SHEET

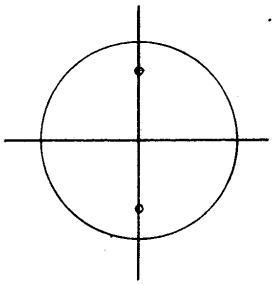
The resistance of each coil is about 1000 ohms. The coils are identical and may be interchanged in function or hooked together in series when the unit is used as a frequency sensing device. Since the direction of winding of the coils is important when it is operating as either a frequency standard or sensing device, it may be necessary to switch the pin connections of one of the coils to obtain proper operation.

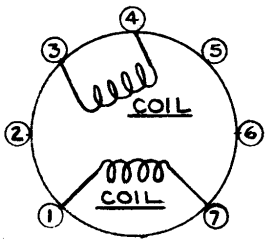
When the unit is operating at resonant frequency, the impedance of each coil is about 10,000 ohms.

The Electro-Mechanical Oscillator may be used in tuning fork circuits or in circuitry of similar devices.

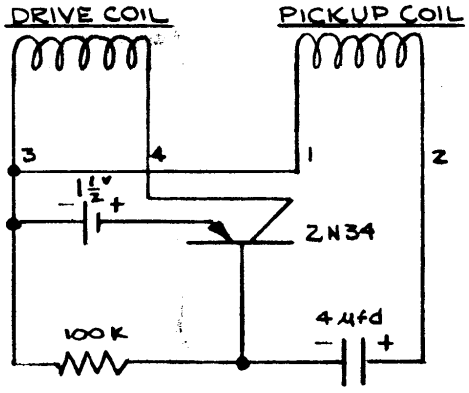
Be careful in checking the resistance of the coils due to the small size of the coil wire. The current should be limited to about 5 milliamperes.







SOCKET CONNECTIONS
WHEN THE UNIT IS
PROVIDED WITH A
7 PIN MINIATURE BASE



SINGLE TRANSISTOR CIRCUIT

ELECTRONICS DIVISION
ELGIN NATIONAL WATCH COMPANY
107 National Street, Elgin, Ill.

APRIL 1957